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(54) Cooler for a furnace

(57) A cooling element (10) for a furnace comprises a serpentine tube (20) cast into a copper surround (22) to carry cooling water. The copper surround is shaped so as to facilitate removal and replacement of one cooling element from a line of such elements. The cooling element is provided with distance pieces (24) to hold it away from the furnace shell (12) and is provided with support means comprising hollow cylinders (36) to which are attached ears which engage lugs (28). The cooling element is secured to the outside of the shell (12) by nuts on a threaded part of the hollow cylinders (36) that pass through the shell. The tube (20) protrudes from the surround (22) and passes through the hollow cylinders (36) to provide a water inlet and outlet.

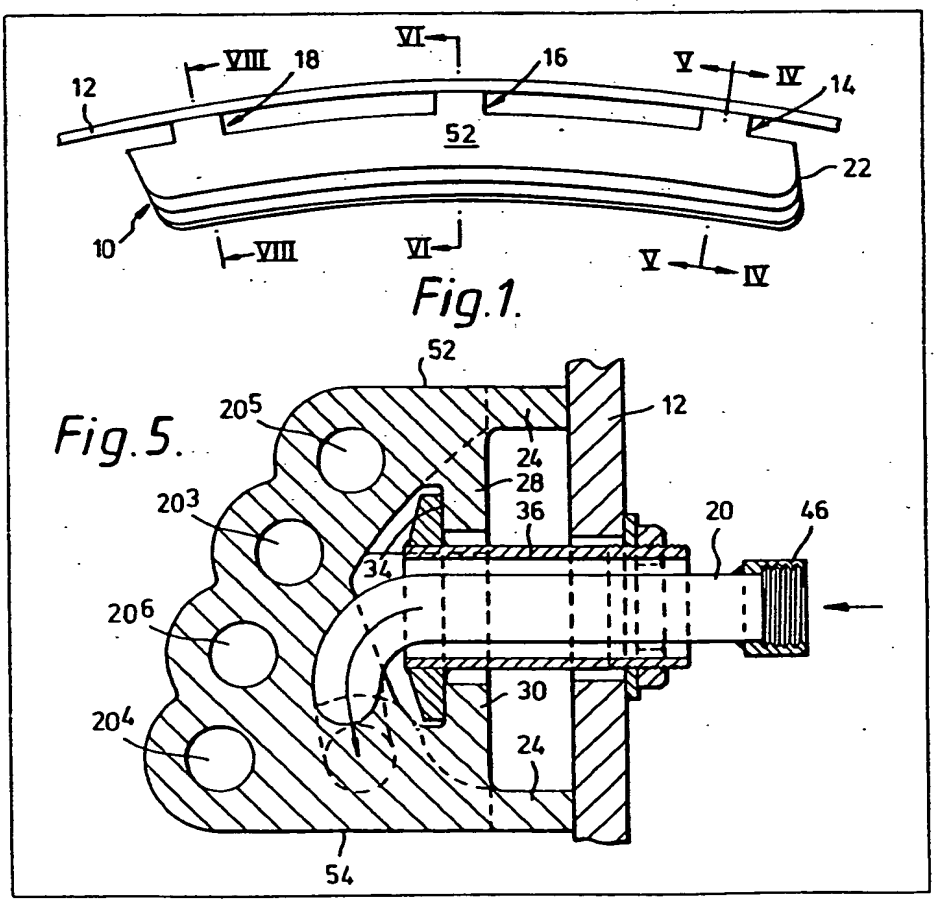

Fig.1.

Fig.5.

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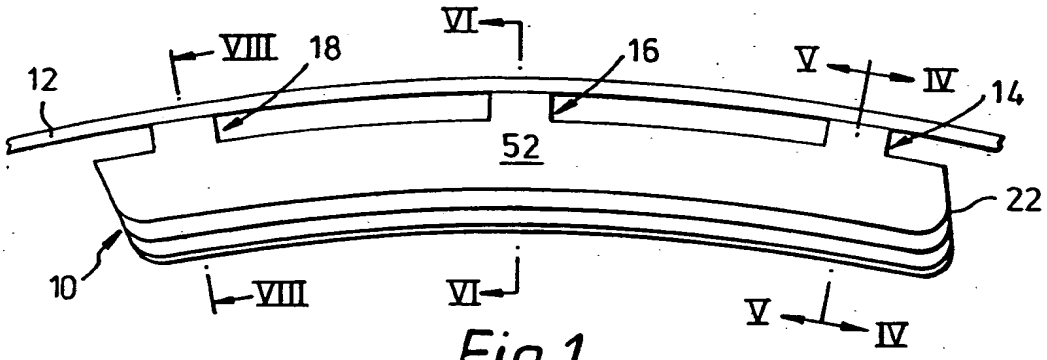


Fig.1.

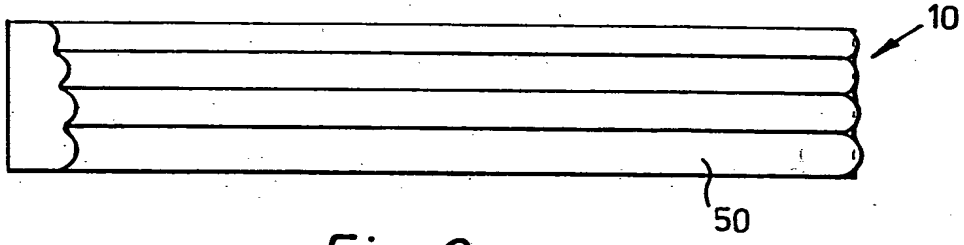


Fig.2.

Fig.3.

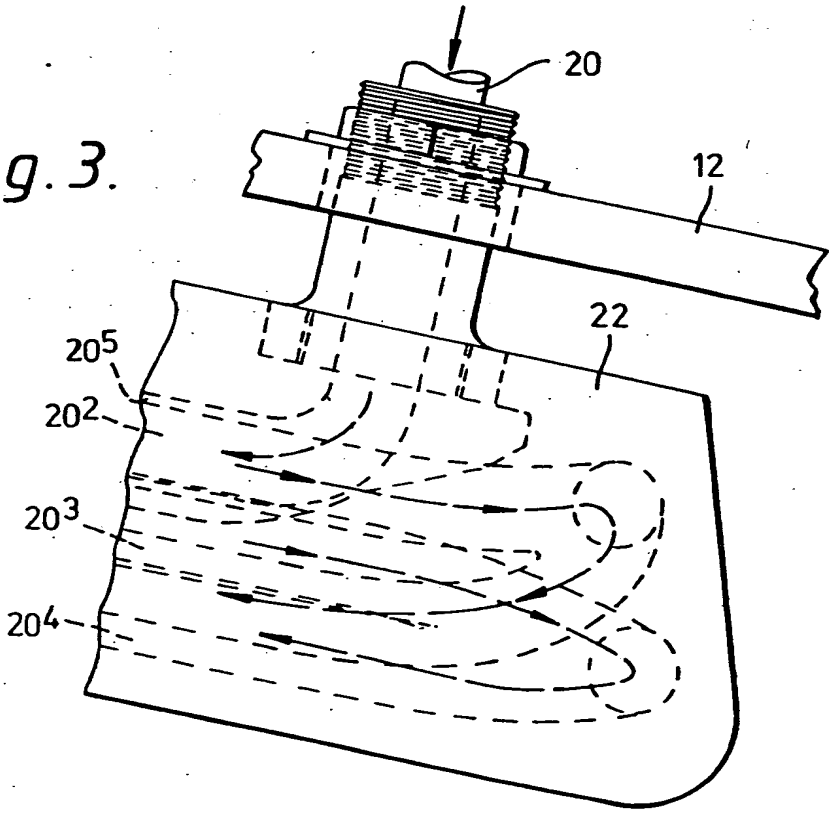


Fig.4.

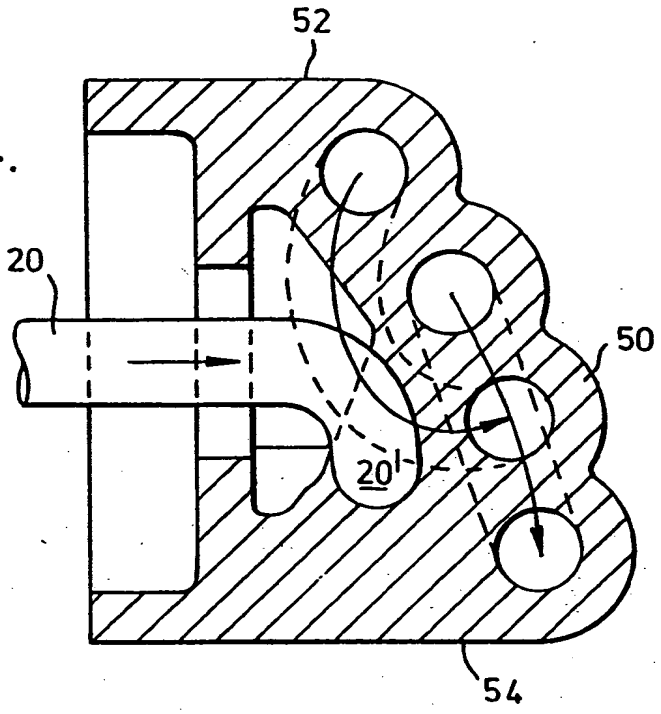


Fig.5.

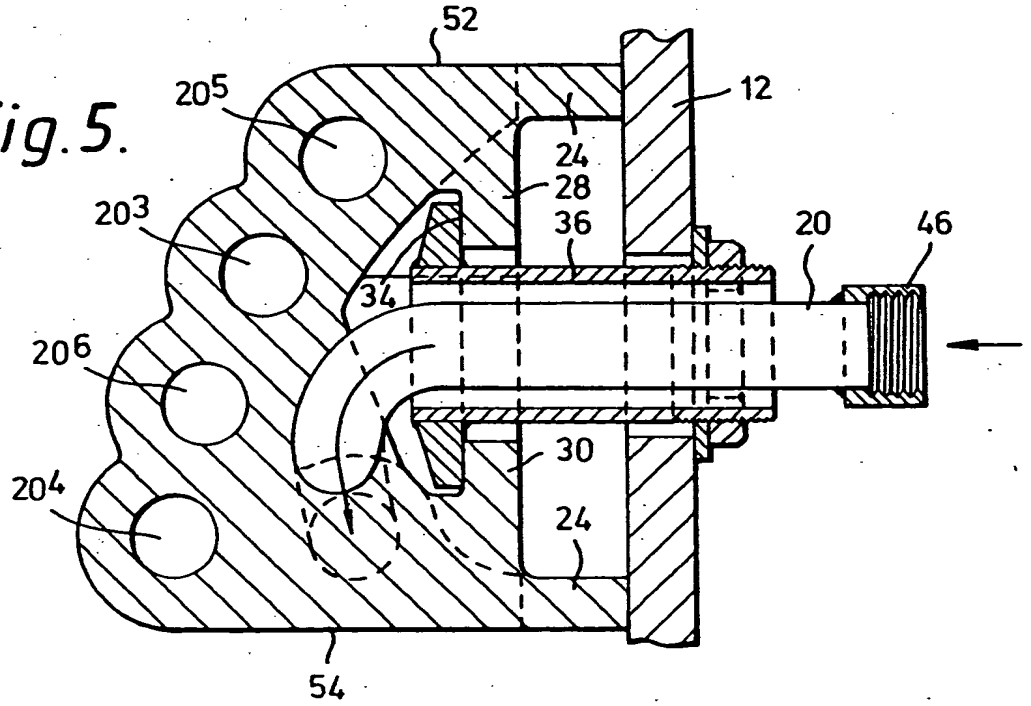


Fig. 6.

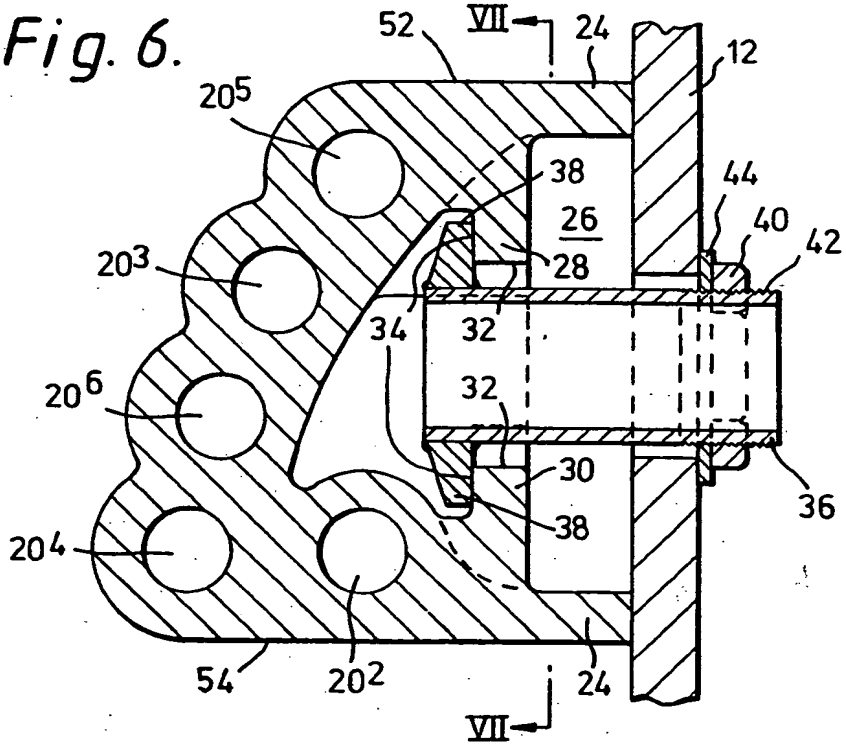
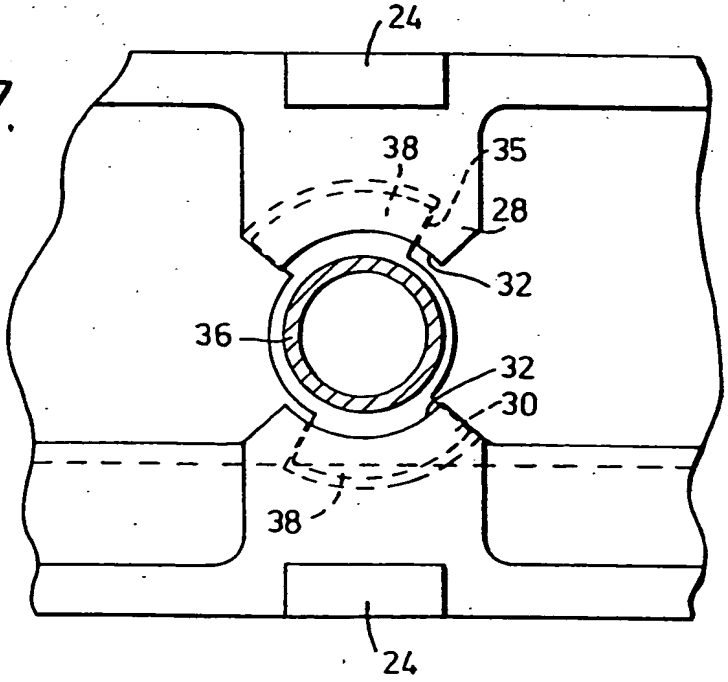

52
VII
24
12
20^5
38
26
28
44
40
42
20^3
34
32
32
20^6
30
38
36
20^4
54
20^2
24
VII

Fig. 7.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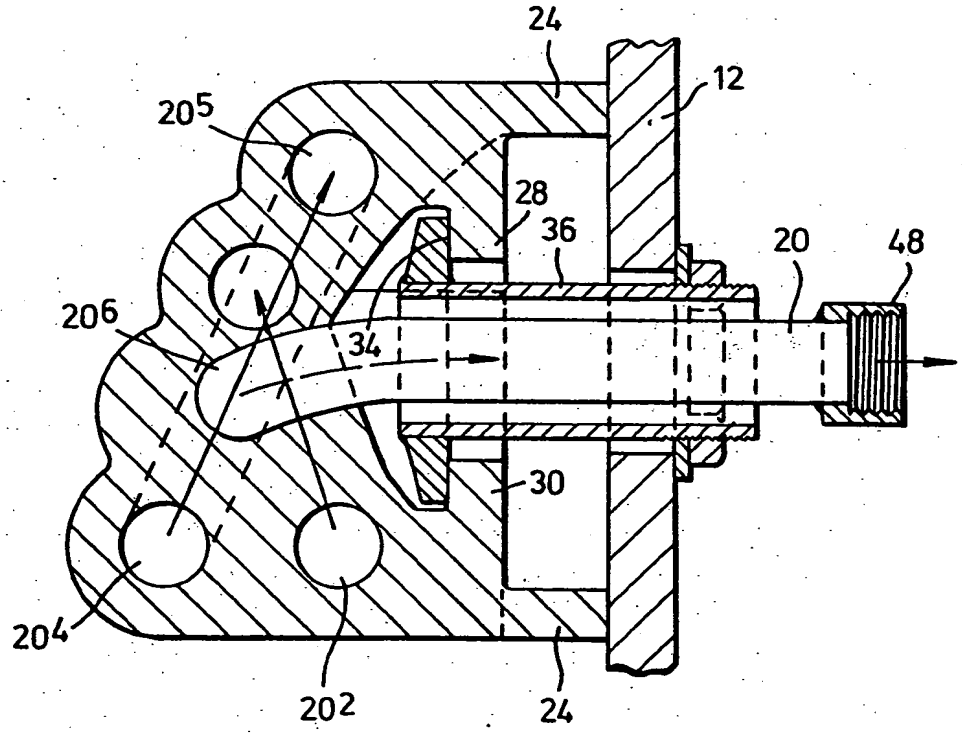

Fig.8.

SPECIFICATION

Cooler for a furnace

This invention relates to coolers for furnaces, and is particularly concerned with coolers for steel-melting arc furnaces, though the cooler of the invention is not confined to use in such furnaces.

The walls, hearth and roof of arc furnaces were traditionally lined with refractories. This, however, meant that the refractory lining of the furnace had to be renovated at fairly frequent intervals, probably after a few weeks operation.

Within the last ten years or so, water cooled elements have been used in arc furnaces, in the form of steel panels with water circulating through them: these panels are designed for use without a refractory lining, but are designed to retain slag splashed onto them to form a protective layer. The use of such panels has dramatically reduced the consumption of refractories in steel arc-making furnaces. However these steel panels are normally only used down to about 500 mm above the slag line, as they do not stand up to the temperatures encountered nearer the slag line, nor to washing by slag. This means that an area is left below the steel panels which can be rather rapidly eroded by slag attack.

Copper coolers are less liable to thermal damage than steel coolers, and more recently copper coolers have been introduced which can be used down to within 200 mm of the slag line. Such a cooler is described in U S Patent 4 304 396 (Nikko Industry Co. Ltd.). The cooler includes a heat-receiving copper plate on the side nearest the furnace, a steel or copper back plate spaced therefrom, and a zigzag flow channel for water formed between the two plates by a number of steel partitions welded to the two plates. Inlet and outlet water pipes lead through the furnace shell, and the cooler is held to the furnace shell by four seats with a tapped bore, which are retained against the furnace shell by screwed bolts passing through the shell.

Advantageously a cooler for a furnace should have the following features:—

(1) it should be so constructed as to be reasonably cheap to manufacture

(2) the number of holes through the furnace shell should be kept small

(3) provision should be made for any slight misalignment of the holes through the furnace shell

(4) the basic design of any particular cooler should be adjustable to fit furnace shells of slightly different radii

(5) the cooler should be shaped and held so as to permit of easy removal of the cooler from inside the furnace without disturbing any adjacent coolers

(6) the face of the cooler directed towards the interior of the furnace should be such as to retain slag splashed thereon.

The new cooler of this invention in its broadest aspect fulfils at least one of the advantages represented by the above features, and in its preferred form is thought to possess all the features.

The cooler of the present invention comprises a serpentine tube cast into a copper or copper alloy surround leaving portions of the tube protruding from the cooler to form a water inlet and outlet, means being provided to hold the cooler against the shell of the furnace, this means comprising an element passing through the furnace shell. In one form of the invention this element surrounds the said protruding portions of the tube: if the cooler is of such size that two holding means are considered insufficient, further holding means may be provided, such further holding means having no tube passing therethrough.

If desired, the cooler may embody a second cooling tube, also cast into the copper or copper alloy surround, this second tube also having portions protruding from the back of the cooler to form a water inlet and outlet for this second tube. Thus additional cooling may be obtained by passing separate flows of water through the two cooling tubes.

A preferred form of holding means takes the form of a hollow cylindrical member with at least one ear at its inner end, this member being rotatable within a hole in the furnace shell to bring the ear behind a ledge formed in the body of the cooler. The member may be externally screw-threaded at its outer end, so that it can be held and urged outwardly by a nut screwed against the furnace shell through a washer.

The parts of the cooler which abut the furnace shell may be the ends of distance pieces formed on the body of the cooler and located adjacent the holding means. By slightly adjusting the length of the distance pieces, and/or the inclination of the ends thereof, provision may be made for minor variations of diameter of the furnace.

A preferred shape of the cooler provides for the ends of the cooler to be angled in the same direction relative to normals from the furnace shell in such a way that, having released the cooler from the holding means, the cooler can be pulled away from the furnace shell at one end and then moved longitudinally without disturbing similar coolers located adjacent to the cooler being so removed. The cooler is also preferably so shaped that its front face, directed towards the interior of the furnace, is ridged and it may also be angled inwardly, so as to retain splashed slag on its surface.

If desired, a small water chamber may be interposed in one or both of the portions of the tube protruding from the cooler: such a

chamber may be located wholly or partly between the back of the cooler and the furnace shell, for example at the top or the bottom of the cooler (and if there are two such chambers one may be adjacent the top and the other adjacent the bottom of the cooler). If such chamber or chambers are used, additional cooling is given to the furnace, the inlet water leading into the chamber and then into the cooler, and/or the outlet water leading from the cooler into the chamber and then through the furnace shell.

In a particularly preferred form of the invention the serpentine tube in the cooler forms more or less parallel passages along the cooler, these passages being fairly close to each other, but not arranged in the true zig-zag fashion—that is to say, the water does not pass directly from each passage (other than the last passage) into a passage immediately adjacent thereto. This has two advantages: firstly, the U-turns at the ends of the passages need not be sharp, and secondly, the coolest part of the water in the passages nearest the inlet are not concentrated near the top or the bottom of the cooler, so that more even cooling over the whole surface is obtained.

One form of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a plan view showing the cooler in position on a furnace wall; and

Figure 2 is an elevation, both figures being on a smaller scale than the remaining figures;

Figure 3 is a view showing the right-hand end of Fig. 1;

Figures 4 and 5 are respectively sections on the lines IV–IV and V–V in Fig. 1;

Figure 6 shows a section on the line VI–VI in Fig. 1;

Figure 7 is a section on the line VII–VII in Fig. 6; and

Figure 8 is a section on the line VIII–VIII in Fig. 1.

The cooler, generally indicated by reference numeral 10 in Figs. 1 and 2 is secured to the shell 12 of a furnace at the positions 14,16,18, the method of fixing being shown in further detail in Figs. 5 to 8.

The cooler 10 comprises a thin-walled stainless steel tube 20 which is cast into the copper body 22 of the cooler, except at its ends which form a water inlet shown in Figs. 3, 4 and 5 and a water outlet shown in Fig. 8, the protruding ends being long enough to pass through holes in the furnace shell when the cooler is fitted to the furnace. The tube 20, from its point of entry into the cooler, shown as 20^1 in Fig. 4 passes along the length of the cooler to form a water passage 20^2. At the end adjacent the outlet it is bent back in a U-turn to provide a water passage 20^3 which, at the end adjacent the inlet, forms another U-turn to provide a further passage 20^4. Two further U-turns at opposite ends of the cooler give water passages 20^5 and 20^6 along the length of the cooler, after which the tube 20 exits from the cooler, as shown in Fig. 8. There is thus provided a serpentine form for the stainless steel tube within the copper body 22 of the cooler.

The cooler 10 is fixed to the furnace shell 12 at three positions 14,16,18, and the support 16 will now be described in more detail. It is shown in Figs. 6 and 7. At this point the copper casting of the cooler is extended to provide two distance pieces 24 which hold the main body of the cooler 10 away from the furnace shell 12, leaving a space 26 between this shell and the main body of the cooler. Where the cooler is to be supported, the copper casting forms two lugs 28,30, the shape of which is seen in Figs. 6 and 7. These lugs are directed towards each other, leaving a gap between them, the ends 32 of the lugs which face each other being curved to form the circumference of a common circle, each end 32 occupying slightly more than a quadrant of the circle. Behind the lugs 28,30 are ledges 34.

A fixing sleeve 36 in the form of a hollow cylinder has two ears 38 welded to its inner end, these two ears being of such a size that, when they are positioned so as to be horizontally opposed to each other, they can be pushed through the gap between the lugs 28,30, after which rotation of the sleeve 36 brings the ears 38 behind the ledges 34 as shown in Fig. 6 and in broken lines in Fig. 7. The casting is so made as to provide a stop 35 to the movement of the ears 38. Now the sleeve 36 can be pulled outwardly by means of a nut 40 screwed onto an external thread 42 on the sleeve. A washer 44 is located between the nut 40 and the shell 12 of the furnace.

At the positions 14, 18, the cooler is fixed to the furnace shell in the same way and the projecting part of the tube 20 passes through the interior of the sleeve 36. As seen in Figs. 5 and 8 the ends of the tube 20, forming a water inlet and water outlet respectively, are joined to conduits 46, 48 for supply and removal of the cooling water.

The cooler 10 is of course made for a particular diameter of furnace shell. However any particular cooler body can be adapted within limits to different diameters of furnace shell by shortening or lengthening some of the distance pieces 24 and, if necessary, varying the inclination of the end of these where they contact the furnace shell. Thus, shortening the distance pieces 24 shown in Fig. 6 would make the cooler suitable for a larger diameter of shell.

As can be seen from Figs. 1 to 3, both ends of the cooler are angled in the same direction relative to a normal passing through the furnace shell. If a number of these coolers

are in line, it can be seen that any cooler can be removed after the tube 20 has been released from the conduits 46,48, by loosening the three nuts 40, and rotating the fixing sleeves 36 until the ears 38 are freed from the ledges 34. Then the right-hand end of the cooler can be pulled inwardly until it is free from the adjacent cooler and the whole cooler can be pulled to the right and away from the furnace shell.

Figs. 2, 4, 5, 6 and 8 show how the casting of the copper to form a more or less even layer of copper over the tube 20 forms a series of four ridges, presenting a front face 50 which is angled inwardly and upwardly to receive and retain slag splashed on its surface. If desired, further means may be provided to hold the slag, such as protrusions from the front face 50, or ribs around the top and bottom faces 52, 54, to prevent slag penetration.

The above described cooler is particularly valuable for use in arc furnaces where they can be employed a short distance above the slag line, and at other places such as hot spots around the walls close to the electrodes, but is by no means limited to this particular application.

It may be advantageous to insulate the cooler electrically from the furnace shell, for example by the use of insulating pads at the ends of the distance pieces 24 and insulating sleeves in the holes in the shell, thus reducing the possibility of electrical discharge between the electrode and the cooler.

CLAIMS

1. A cooler for an arc furnace comprising at least one serpentine tube cast into a copper or copper alloy surround, leaving portions of the tube protruding from the surround to provide a water inlet and outlet, means being provided to hold the cooler against the furnace shell, said means comprising an element passing through the furnace shell.

2. A cooler according to claim 1 wherein the said element passing through the furnace shell is hollow and a said protruding portion of the tube passes outwardly of the furnace shell through the hollow element.

3. A cooler according to claim 2 wherein the cooler is held against the furnace shell by more than two such elements, some only of the elements having protruding portions of the tube therethrough.

4. A cooler according to any preceding claim where the serpentine tube in the cooler forms more or less parallel passages a long the cooler arranged so that water does not pass from a passage (other than the last passage) into a passage immediately adjacent thereto.

5. A cooler according to any preceding claim where the copper casting is provided with lugs at the position where the cooler is to be supported, said lugs being curved to form the circumference of a common circle directed towards each other.

6. A cooler according to claim 5 wherein the holding means is in the form of a hollow cylindrical member, this member being rotatable in the furnace shell and provided with ears at its inner end, of such a size that they can pass through the gap between the lugs, the cooler being secured against the furnace shell by engaging the ears against these lugs and urging the hollow cylindrical member outwardly.

7. A cooler according to any preceding claim where the parts of the cooler abutting the furnace shell are distance pieces formed on the body of the cooler, the size and shape of said distance pieces being adjustable to allow for variation in furnace diameter.

8. A cooler according to any preceding claim where the ends of the cooler are angled in the same direction relative to the normals from the furnace shell.

9. A cooler according to any preceding claim where the inwardly directed face of the cooler is angled inwardly and upwardly to receive and retain slag splashed upon this surface.

10. A cooler according to any preceding claim where the inwardly directed face of the cooler is provided with a series of ridges or protrusions to receive and retain slag splashed upon this surface.

11. A cooler according to any preceding claim wherein there is a second cooling tube, also cast into the copper or copper alloy surround, this second tube also having portions protruding from the back of the cooler to form a water inlet and outlet for this second tube.

12. A cooler according to any preceding claim having a water chamber interposed in one or both of the portions of the tube protruding from the cooler.

13. A cooler according to claim 12 wherein the chamber is located wholly or partly between the back of the cooler and the furnace shell.

14. A cooler substantially as described herein with reference to the accompanying drawings.

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